APPLICATION NOTE

What's the Difference Between True View and Source Estimate Mode?

Two Methods for Oscilloscope Probe Response Correction

When you connect a probe to your oscilloscope, your probe becomes part of the circuit affecting your test. This is called probe loading. There are two common methods for correcting the probe response: True View (Vout/Vin) and Source Estimate (Vout/Vsource). Learn the basics behind these two methods, understand their advantages and disadvantages, and chose which method is best for your application.

True View (Vout/Vin)

Shows the voltage at the tip of the probe as loaded by the probe.

Source Estimate (Vout/Vsource)

Estimates the voltage at the probe point as if the probe is not there (assumes 25 ohm source impedance).

Basic Definitions

Let's start with a few basic definitions.

- **Vsource** - The signal at the probe point "before" the probe is connected. This would be the signal at the probe point if an ideal probe with infinite input impedance were connected.
- **Vin** - The signal at the probe point while the signal is being loaded by the probe. Probe loading is caused by the input impedance of the probe making a voltage divider with the source impedance of the circuit being measured.
- **Vout** - The signal that is output from the probe. Also, the signal that is shown on the scope screen.
- **Source impedance** - The impedance of the circuit that is driving the probe, which is the impedance looking back to the point being probed with the probe connected.

The diagram on the next page shows these definitions visually (Figure 1).

KEYSIGHT TECHNOLOGIES

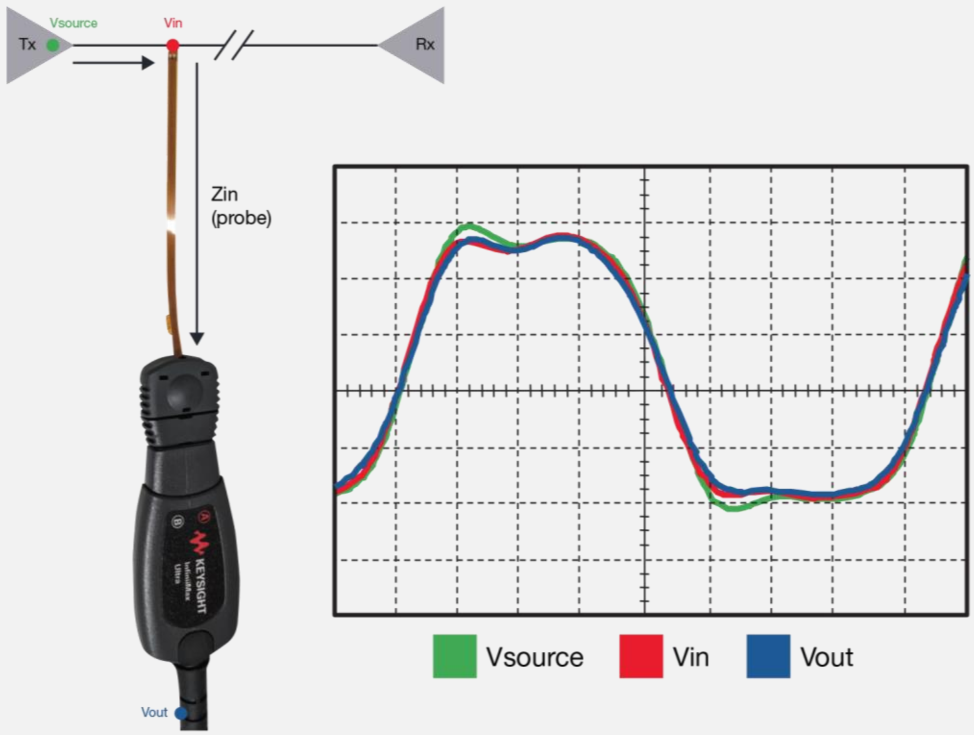

Figure 1. Visual depiction of Vsource, Vin, Vout, and Source Impedance

True View (Vout/Vin)

The True View method shows the voltage at the tip of the probe as loaded by the probe. This is known as Vout/Vin. True View is a more accurate representation of the signal that currently exists as it is being probed. It is designed to closely match Vin, the signal at the probe point.

In this mode, the voltage transfer function and the input impedance are independent. Changing the source impedance driving the probe does not change the transfer function and vice versa. It may change what you see on the scope but this is because the source impedance is dividing against the input impedance of the probe, not because it's actually changing the transfer function.

True View is better for receiver sensitivity testing because you want to measure the signal that is actually there. It doesn't hide the fact that the probe loaded the signal, so it may appear that your signal has a slower rise time.

Source Estimate (Vout/Vsource)

The Source Estimate method estimates the voltage at the probe point as if the probe is not there. This is known as Vout/Vsource. The philosophy behind this mode is the desire that the probe should display the unloaded, or original waveform as if the probe isn't there (Vsource). But since there is no such thing as an ideal probe, that is impossible. This method is an estimate of Vsource, assuming a 25 ohm source impedance of the probe.

If the source impedance of the target is 25 ohm and the probe offers a flat frequency response this method will provide a good estimate of Vsource. But otherwise, you are just getting an estimated response of the signal. It's important to note that the impedance looking into the probe point of a DUT is rarely a single real resistance but is typically a complex impedance with reflections and resonances. And even if you can correct the signal, remember that probe loading is still there whenever you are using a probe.

Source Estimate can be better for transmitter testing since you are estimating the signal coming out of the transmitter. But since it hides the effect that probe loading has on the signal being probed, it can hide if probe loading is causing your signal to lose timing or amplitude margin. It does tend to show snappier signals since the algorithm essentially removes the low pass filter of the probe impedance. It will tend to look close to Vsource with a higher peak voltage and faster edges.

Comparison of the Two Methods: True View and Source Estimate

Whichever method you chose for probe response correction is up to you. Here's a summary of the advantages and disadvantages of each method.

	True View (Vout/Vin)	Source Estimate (Vout/Vsource)
Pros	• More accurate representation of the signal that currently exists, as it is being probed • Better for receiver sensitivity because you must measure what is actually there • Doesn't hide the fact that the probe loaded the signal	• More accurate when system source impedance is known • Better for transmitter testing because you are estimating the signal coming out of the transmitter • Can use to correlate with other vendor platforms
Cons	• Doesn't estimate signal that was there before being probed • Shows probe loading and so can appear to have slower rise times	• Error in receiver testing because doesn't show the signal that is actually there while being probed • Hides the effect that probe loading has on the signal being probed, which could hide if probe loading caused your signal to lose some timing or amplitude margin
Transfer Function	• Is the definitive "voltage transfer function" of the probe • Is NOT a function of the input impedance of the probe	• Is NOT the definitive "voltage transfer function" of the probe • Is a function of the input impedance of the probe and the source impedance of the system being probed

Let's look at a comparison of the two methods on the scope screen (see Figure 2). We are using an MX0025A 25 GHz InfiniiMax Ultra Series probe amplifier with the MX0100A 25 GHz Micro Probe head. The blue trace is the signal (Vin). The brown trace is the signal probed in True View mode (Vout/Vin), which is very close to the signal. The Keysight InfiniiMax Ultra Series can easily switch modes with just a push of a button, so we can change the mode without changing the setup. The yellow trace is the signal probed in Source Estimate mode (Vout/Vsource), which shows a faster rising edge because it is estimated by removing the probe load driven by 25 ohms. Note that the plots shown are the step responses of the probe and are a little outside the bandwidth of the probe. The differences between the two modes (True View and Source Estimate) are more in Figure 2 than would be observed inside the bandwidth of the probe but would still be similar in shape.

Figure 2. Visual depiction of the difference between signal (Vin - blue trace), True View (Vout/Vin – brown trace), and Source Estimate (Vout/Vsource – yellow trace).

Example: Clock RMS Jitter of PCIe Gen4

Here's a real-world example of the differences between True View and Source Estimate Mode. A high-speed signal validation R&D engineer wanted to test the PCIe Gen4 clock in her design. She setup her test as in the diagram in Figure 3.

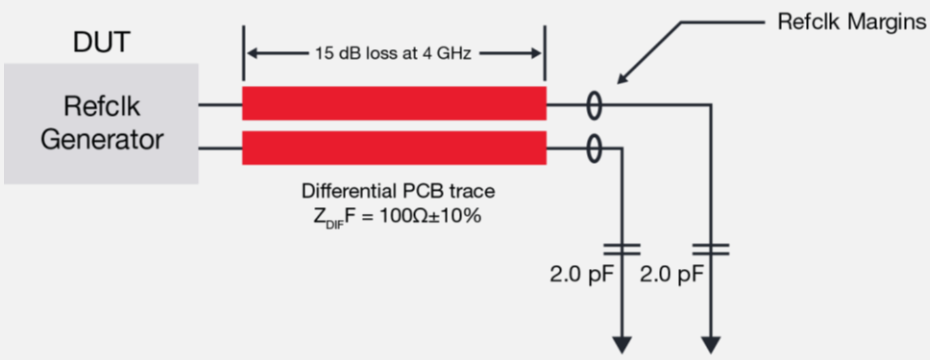

Figure 3. Clock RMS Jitter Test Setup for PCIe Gen4

She created two different setups with two different probes. Test setup A with probe A was a probe with True View response correction. Test setup B with probe B used a probe with Source Estimate response correction. The test setups were identical except for the probe and corresponding probe head. Each probe was calibrated and de-skewed before the test. The test results differed between two, causing the test with probe B (Source Estimate) to pass, but fail with probe A (True View). Why is that? Which probe is better to use?

For Gen4, the RMS jitter is 548.01 fs with probe A (True View), causing a failed compliance test (Figure 4). With Probe B (Source Estimate), the RMS jitter test passed with 451.98 fs (Figure 5).

Filter Compliance Summary

Class	Data Rate	Architecture	Specs	Max HF RMS	Max LF RMS	Max Pk-Pk	Compliance Summary
GEN1	2.5 Gb/s	Common Clock	1.1 2.1 3.1	3.01 ps	1.76 ps	30.31 ps	All PASS
GEN2	5 Gb/s	Common Clock	1.1 2.1 3.1	1.99 ps	718.86 fs	47.37 ps	All PASS
GEN3	8 Gb/s	Common Clock	3.1 4.0	549.60 fs	153.04 fs	5.13 ps	All PASS
GEN4	16 Gb/s	Common Clock	4.0	548.01 fs	153.04 fs	5.08 ps	4 FAIL
GEN5	32 Gb/s	Common Clock	5.0	181.63 fs	69.77 fs	1.73 ps	4 FAIL
GEN6	64 Gb/s	Common Clock	6.0	122.27 fs	29.09 fs	1.10 ps	4 FAIL

Figure 4. Test results with probe A (True View)

Filter Compliance Summary

Class	Data Rate	Architecture	Specs	Max HF RMS	Max LF RMS	Max Pk-Pk	Compliance Summary
GEN1	2.5 Gb/s	Common Clock	1.1 2.1 3.1	2.70 ps	1.70 ps	26.67 ps	All PASS
GEN2	5 Gb/s	Common Clock	1.1 2.1 3.1	1.71 ps	697.10 fs	45.33 ps	All PASS
GEN3	8 Gb/s	Common Clock	3.1 4.0	453.87 fs	152.98 fs	4.19 ps	All PASS
GEN4	16 Gb/s	Common Clock	4.0	451.98 fs	152.98 fs	4.16 ps	All PASS
GEN5	32 Gb/s	Common Clock	5.0	146.49 fs	68.23 fs	1.42 ps	All PASS

Figure 5. Test results with probe B (Source Estimate)

We can look closer at the captured waveforms with each probe in Figures 6 and 7. You can see that Probe B (Source Estimate) has some overshoot which likely speeds up the dv/dt of the edge and therefore helps jitter. Remember that this signal is based on Vout/Vsource and is an estimated signal because the Vout/Vsource peaks its response based on a 25 ohm source driving the input loading. The response tends to be peaky, and gives faster, snappier edges that tend to boost the signal more. Thus the device passed with probe B. But was this really the signal before the probe is connected or was it just an estimated boost? It’s hard to tell.

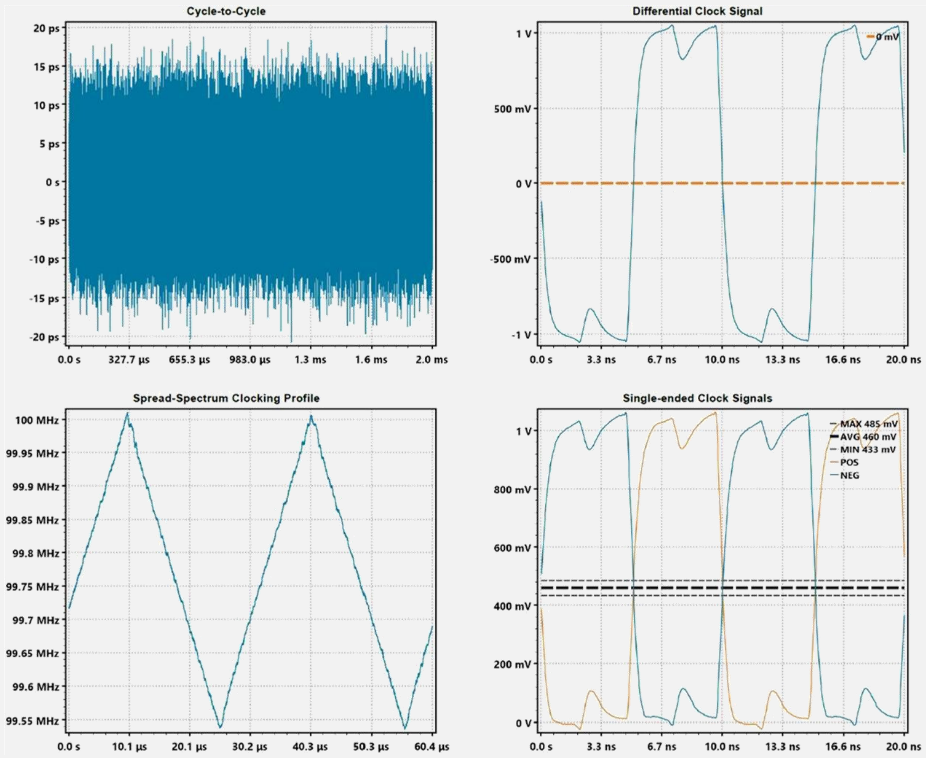

Figure 6. Captured waveform with probe A (True View)

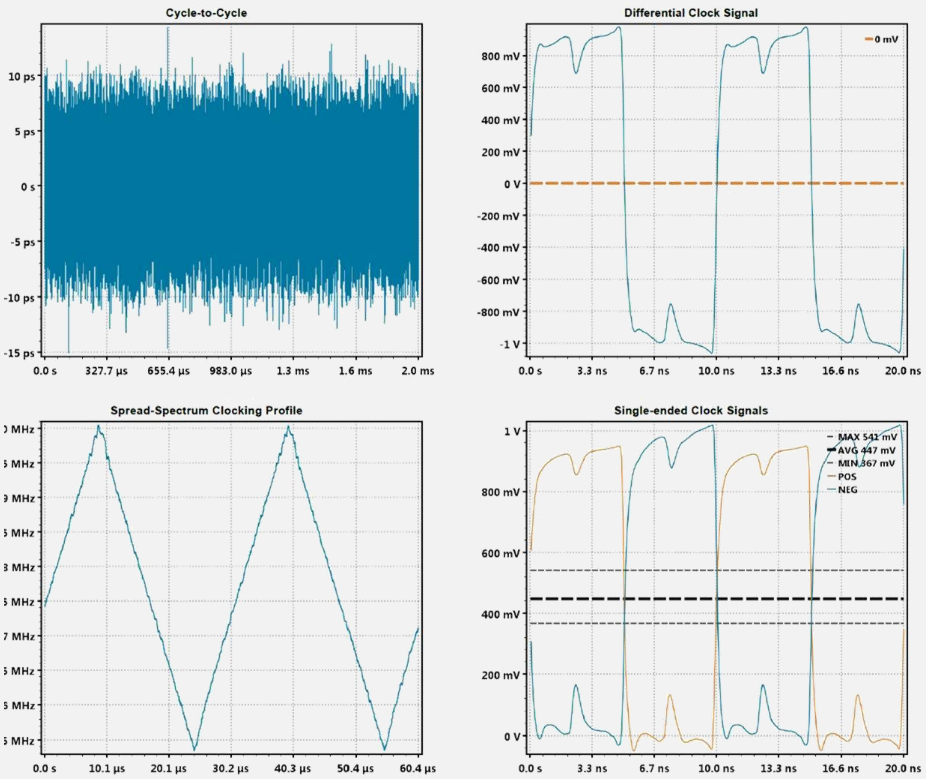

Figure 7. Captured waveform with probe B (Source Estimate)

The engineer used her data to go back into her original design and see where she could improve. Understanding the measurement results and the way the probe correction was calculated helped her make a better decision on what to do with the data. Understanding exactly what the measurements from your oscilloscope and probing system mean will help you when you are coming to design decisions in your own projects. Some questions to consider regarding probe correction methods are: Is this really the most accurate measured signal or is it an estimated boost? Would you want to ship your device to your customer passed by a boosted signal in the test? Now by understanding the two common probe response correction methods, you are able to choose which mode is best for you and recognize the implications of that choice.

Switch Easily Between the Two Methods in Keysight Probes

Now that you've seen the benefits of each of the two methods you might want to compare your measurement results with both. Keysight's InfiniiMax Ultra Probes make it easy to switch between the two methods. If the probe has an AutoProbe 2 interface, there is a button on the probe amplifier to toggle back and forth (Figure 8). If the probe has an AutoProbe 1 interface, you can go up to Probe Configuration menu on your scope screen and change the mode (Figure 9). Most other Keysight probes are configured to natively measure in True View mode, but you can still change the probe response correction method with the D9010DMBA PrecisionProbe software (Figure 10). And with the InfiniiSim software (D9010DMBA Basic InfiniiSim or D9020ASIA Advanced InfiniiSim) you can further customize the probe response correction by using an s-parameter model of your DUT. This allows you to remove the effects of probe loading if your source impedance can't be approximated by 25 ohms.

Figure 8. Easily toggle back and forth between the two methods with a push of a button on Keysight's InfiniiMax Ultra probe amplifiers with AutoProbe 2 interface

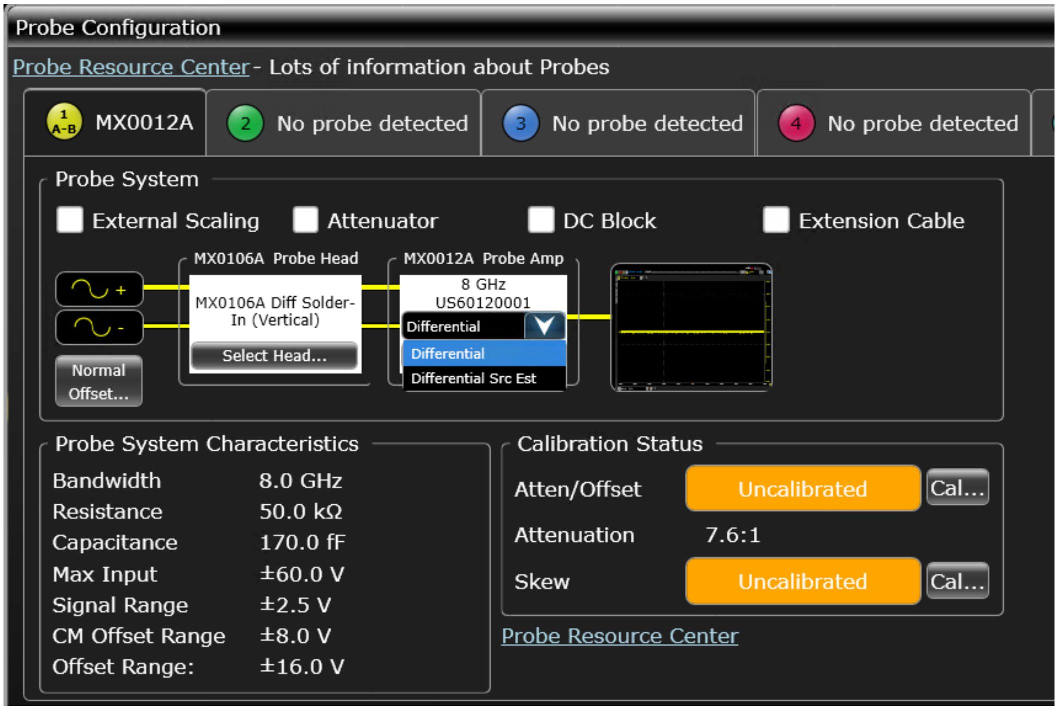

Figure 9. Go to the Probe Configuration menu on your scope screen and easily change between the two methods on Keysight's InfiniiMax Ultra probe amplifiers with AutoProbe 1 interface (available with AutoProbe 2 as well)

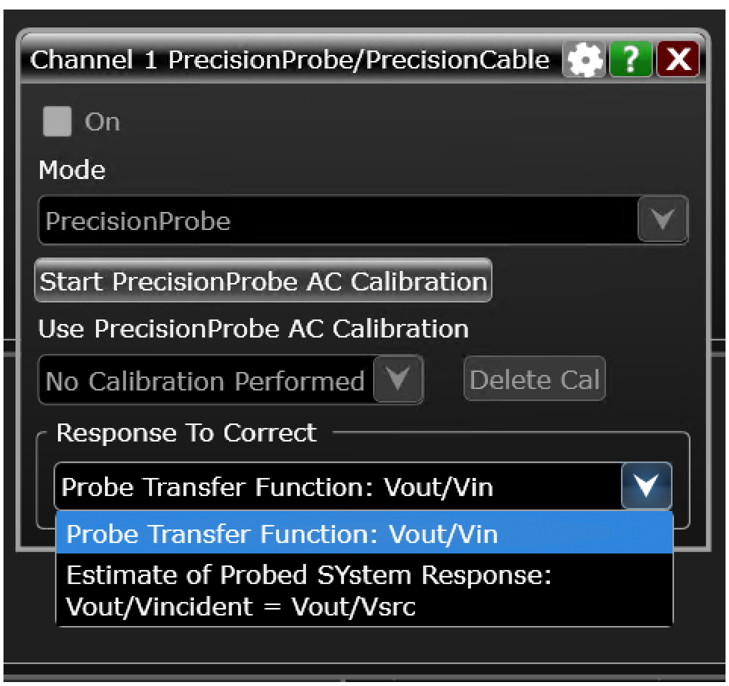

Figure 10. With Keysight's D9010DMBA PrecisionProbe software you can change the probe response correction for any probe

Conclusion

When margins are narrow and design decisions are crucial, you want full trust and control of your measurements. Now you understand how a new feature in Keysight's InfiniiMax Ultra Series probe amplifiers gives you more control over how your measurements are calculated on your oscilloscope. It's easily being able to switch between the two common methods for correcting the probe response: True View (Vout/Vin) and Source Estimate (Vout/Vsource).

More Information

For more information on Keysight's probing solutions, please check out:

- Infiniium Probes and Accessories Datasheet
- InfiniiMax Ultra Series Probes and Accessories Datasheet